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(84) Apparatus and method for injection molding lenses.

(87) An apparatus and method for molding polycarbonate lenses is disclosed in which the lenses are formed in a single injection molding operation. Polycarbonate is injected into a cavity (88) between two movable dies (59, 60) which are forced apart by the injected polycarbonate. These dies (59, 60) are then urged together forcing a portion of the injected polycarbonate back through the same port through which the polycarbonate was injected. The finished lens does not have the knit line normally associated with injection molded lenses.

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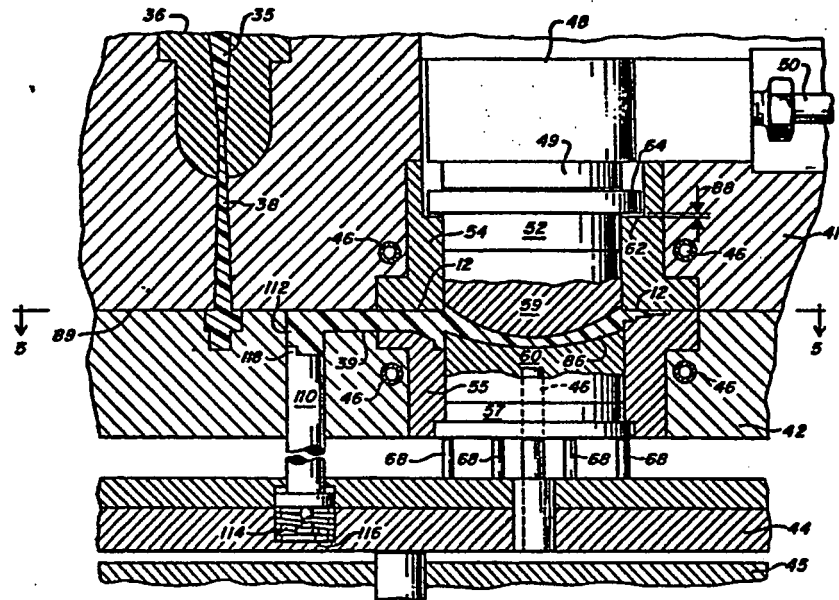


FIG. 4

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APPARATUS AND METHOD FOR INJECTION MOLDING LENSES

This invention relates to lens molding and more particularly, to injection molding apparatuses and techniques.

There have been several attempts, in the prior art, to mold both plus and minus polycarbonate ophthalmic lenses. Minus lenses are lenses that are thinner in their center and thicker along their edges, and plus lenses are lenses that are thicker in their center and thinner along their edges.

Methods and apparatuses for molding lenses have utilized both compression and injection molding techniques as well as a combination of the two. One problem frequently associated with injection molding of lenses is that the lenses produced often contain a knit line. The manner in which this knit line is formed is described below with reference to Figs. 1a-1d.

Referring first to Fig. 1a, a cavity 29 of an injection molding apparatus is illustrated which includes an inlet 28. The injected molten plastic 35 is illustrated as the plastic first enters the cavity 29. Assume for sake of discussion that the lens being fabricated within cavity 29 has a thinner center 33, such center being thinner than the outer edge of the lens. As the plastic 35 enters the cavity 29 it tends to flow to the outer perimeter of the cavity 29, since the cavity is thicker in this region. In Fig. 1b the plastic 35 is again illustrated as it continues to fill the cavity 29. As may be seen in this figure, the plastic 35 does not immediately flow into the thinner center 33 of the cavity 29 but rather continues to advance about the outer rim of the cavity. In Fig. 1c the continued flow of the plastic 35 is illustrated, however, in this figure as may be

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1 seen, the plastic has flowed through the thinner center of the
lens. As the plastic meets within the thinner center of the
cavity a knit line 31 develops at the seam along which the flow
meets. In Fig. 1d the cavity is illustrated completely filled
5 with the plastic 35, and the knit line 31 which is inherent in
conventional plastic flow (for any cavity having a thin center)
is illustrated. This knit line prevents the use of the resultant
blank as an optical lens without additional treatment, such as
polishing.

10
Another problem associated with the formation of a
lens in a single injection molding operation is that during the
curing of the plastic, shrinkage occurs which results in an
uneven and wavy exterior surface on the finished lens blank.
15 Such shrinkage may also cause bubbles and other imperfections in
the interior of the lens, and these defects will cause optical
distortions and aberrations which are unacceptable for
prescription lenses and instrument lenses.

20 Ideally, a lens should be produced in a single injection
molding operation. As will be seen, the method and
apparatus of the present invention provide for the injection
molding of an optical lens which results in a finished lens blank
which requires fewer finishing operations. The finished blank
25 may be thin (approximately 1 millimeter) at its center so as to
result in an optically correct, lightweight and asthetically
pleasing eye glass lens which is shatter proof.

30 U.S. Patent Nos. 4,008,031 and 4,091,057 disclose an
apparatus and method for producing a lens in which a clear
thermoplastic such as acrylic or polycarbonate is forced between
the two mold halves which define the optical blank. These mold
halves are forced away from each other as the cavity is filled
with the molten plastic. An inner press which is disposed within
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1 the injection molding apparatus urges the mold halves together
once the mold is filled to a certain level with the molten plastic. The urging of the mold halves together causes a certain
amount of the molten plastic to be forced through an outlet port
5 into a self-adjusting overflow pocket. This outlet port is spaced
away from the inlet port, and there may be more than one outlet
in communication with the cavity.

One problem associated with the method and apparatus utilizing transfer pockets is that additional finishing operations must
10 be performed on the fabricated lens in order to remove the transfer pockets and the plastic that cured in the inlet port. In general, lenses would be produced at a much faster rate if these finishing operations could be reduced or eliminated.

15 It is therefore a principal object of the present invention to provide an apparatus and method which will produce lenses of good quality using a combination of injection and compression molding techniques in which no such additional transfer pockets to be removed
20 lateron are necessary. This object is solved by the apparatus according to the main claim and the methods according to claims 9 and 14. Advantageous features of the apparatus and the method are disclosed in the subclaims. By means of the present invention, molten plastic is injected into and compressed out of the mold through the same opening.

25 The invention also provides a method and apparatus of producing an optical blank in which the lens finishing operations are kept to a minimum.

30 The invention provides an apparatus and method for producing a finished optical blank which may be used for an eyeglass lens or the like. The apparatus and process of the present invention is particularly adaptable for lenses which are thinner in the center, such as a concave, or double concave (minus or negative) lens,
35 including single vision, multifocal and cylindrical lenses. The injection molding apparatus utilized in the present invention

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1 includes an inner press disposed within an outer, conventional,
injection molding apparatus. The inner press includes optical
inserts which define an optical lens cavity. This cavity, once
filled with a clear thermoplastic, such as acrylic or
5 polycarbonate, produces the finished lens blank. The cavity
includes an inlet port into which the molten plastic is injected,
in a conventional manner. One or both of the optical inserts
which define the optical cavity, move so as to increase the
volume (particularly the thickness) of the cavity when the molten
10 plastic is first injected into the cavity. After the molten
plastic is injected into the cavity, the inner press urges the
optical inserts together, forcing a predetermined portion of the
molten plastic back through the inlet port into an overflow
reservoir which communicates with the passageway leading to the
15 inlet port.

While the apparatus and method of the present invention
eliminate the knit line associated with conventional plastic flow
as well as any apparatus or method in the prior art, the
20 apparatus and method also offer the additional benefit of less
required finishing since the transfer pockets do not have to be
cut from the finished blank since only one port communicates
with the cavity. Furthermore, the apparatus and method will
still compensate for the shrinkage associated with the curing of
25 the blank, and the resultant blank is an optically precise
configuration. The process and apparatus is suitable for both
plus and minus lenses.

30 Figs. 1a, 1b, 1c and 1d illustrate conventional plastic
flow, and the formation of a knit line associated with such flow.

Fig. 2 is a perspective view of a finished blank
produced in accordance with the present invention with a cut-away
35 section used to illustrate the thinner center of the blank.

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1 Fig. 3 illustrates the finished blank of Fig. 2 hung on
a hanger which hanger is formed concurrently with the molding of
the finished blank.

5 , Fig. 4 is a cross sectional view of an injection
molding apparatus built in accordance with the present invention.

Fig. 5 is a plan view illustrating the cavity defined
by the dies or optical inserts of the apparatus of Fig. 4 taken
10 through section line 5-5 of Fig. 4.

The present invention discloses an apparatus and method
for fabricating a finished optical blank which blank may be
15 utilized for eyeglasses, or the like. The resultant finished
blank produced with the present invention requires little, or no,
polishing and the blank may be readily cut or edged to any
desired peripheral shape such that the lens may engage an
eyeglass frame, instrument or the like.

20 Before describing the apparatus, a brief description of
the finished blank 10 of FIG. 2, will be given since it will be
helpful in understanding the apparatus. The finished blank 10
includes a lens area 11 which is edged to any appropriate shape,
25 such as a shape required to fit an eyeglass frame. An annular
rim 12 may be disposed about the exterior of the lens area 11 in
order to facilitate the ejection of the blanks. The inlet runner
or spruce 23 shows the flow of the molten plastic as it enters
the cavity defining the blank 10. In the presently preferred
30 embodiment a tip 25 is defined by the cavity; this tip allows the
plus curved lens to be placed on a flat surface without
scratching the bottom surface of the blank 10. Also defined by
the cavity is a hanger 20. This hanger allows the finished
product to be hung from a pin 21, shown in FIG. 3, or other

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1 device during subsequent processing of the finished blank 10. An
overflow spruce 16 illustrates the effects of compressing the
molten plastic after the plastic has entered the cavity. As will
be explained, once the cavity is filled, the dies are compressed
5 forcing or squeezing predetermined amounts of molten plastic from
the cavity, back through the inlet port and into a reservoir
which defines the overflow spruce 16.

Referring to FIG. 4, the presently preferred embodiment
10 of the apparatus employs compression molding apparatus disposed
within a conventional injection molding machine. The
conventional injection molding machine includes an upper block 41
and a lower block 42 which meet at a mating surface 89. Disposed
within these blocks is an injection nozzle 35 for injecting
15 molten plastic. A plurality of heating rods 46 are disposed
within these blocks (and also below the cavity 86) for heating
the entire injection apparatus, including the optical inserts 59
and 60. The nozzle 35 communicates with cavity 86 through
passageways 38 and 39. The blocks 41 and 42 are secured together
20 through a hydraulic system, exerting, by way of example, a
hundred tons of force.

This disclosed apparatus includes an upper interior
block 54 and a lower interior block 55. Within these generally
25 cylindrical blocks is disposed a hydraulic cylinder 48. A piston
49 which terminates in a flange 64 cooperatively engages the
cylinder 48 for exerting pressure upon the plastic within cavity
86. A spacer 52 is disposed between the flange 64 and an upper
optical insert or die 59. At the lower end of cavity 86 a spacer
30 57, supported from platform 45, is disposed directly below, and
in contact with, the lower optical insert of die 60. Thus, the
cavity 86 is substantially defined by the adjacent surfaces of
the upper and lower dies 59 and 60. Inlet passageway 39 passes
through the blocks 54 and 55 in order that the nozzle 35
35 communicates with the cavity 86.

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1 A hydraulic inlet line 50 is coupled to the cylinder 48
for providing hydraulic fluid to the cylinder when the plastic
contained within cavity 86 is to be compressed. The travel of
the piston 49 is shown by dimension 88 of FIG. 4; this travel is
5 limited by the distance between the flange 64 and the annulus 62
defined by the upper block 54. However, in the presently
preferred embodiment, the travel of pistons 49 (and die 59) is
determined by the period of time during which pressure is applied
to the plastic within cavity 86 and by other means as will be
10 discussed.

 The surface of the dies 59 and 60 defining the cavity
86 are fabricated from a suitably hard metal or glass, which
typically is highly polished with a precise, compensated, curve
15 configuration in order that the finished blank has an optically
clear, distortion free surface. Such optical inserts or dies are
known in the prior art. Moreover, the curved surfaces of these
inserts may be varied, by changing the dies 59 and 60 to obtain
desired lens shapes or powers.

20 A plurality of ejector pins 68 may be disposed about
the circumference of the cavity 86 for contacting the rim 12 of
the finished blank to urge the blank from the cavity once the
blank has been properly cured and the dies have been separated.
25 These pins are coupled to the movable ejection platform 44.
Standard known injection devices may be used for this
application.

 Communicating with the inlet passageway 39 are two
30 pistons: a shut-off piston 100 and an overflow piston 110.
Shut-off piston 100 which is disposed within cylinder 102
controls the flow of molten plastic into the cavity 86. While
molten plastic flows into the cavity, the piston 100 is depressed
in the cylinder 102, and when the cavity has been filled to the

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1 desired level, the piston is forced to extend from the cylinder
thereby closing off the cavity 86 from further plastic flow. As
will be explained later, the piston 100 will also provide a
barrier for the excess plastic returning from the cavity 86 when
5 the dies 59 and 60 are compressed.

The overflow piston 110 which is housed in cylinder 112
communicates with the inlet passageway 39 at a position between
the cavity 86 and the position where the shut-off piston 100
10 communicates with the inlet passageway 39. While the molten
plastic is flowing into the cavity 86 the overflow piston 110 is
locked in a forward position thereby preventing plastic from
flowing into the cylinder 112. The lower end of the overflow
piston 110 is also urged upwardly by a spring 114 mounted between
15 the lower end of the piston 110 and the ejection platform 44. An
adjustable stop 116 determines the limit on the depression of the
piston 110 within the cylinder 112, and when this limit is
reached, the volume between the optical inserts will be that of
the finished lens blank. Since there is only one port (unless
20 the optional hanger 82 is employed in which case there are two
ports) communicating with the cavity 86, the plastic must exit
from the cavity 86 through the inlet port 38 where the plastic
originally entered the cavity.

25 The inlet passageway 39 as is best illustrated in FIG.
5 communicates with the cavity 86 through a right angle bend 23.
This right angle (which is known in the prior art) is used to
diffuse the inlet flow of molten plastic. Also illustrated in
FIG. 5 is a hanger cavity or void 82 which defines the blank
30 hanger 20 illustrated and discussed in conjunction with FIGS. 1
and 2.

The entire apparatus shown in FIGS. 4 and 5 may be
readily fabricated utilizing known technology.

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1 Assume a lens is to be fabricated on the apparatus
shown in FIGS. 4 and 5, and that the desired dies 59 and 60 have
been placed within the apparatus. In the presently preferred
embodiment, a polycarbonate or other thermoplastic is metered
5 into the nozzle 35 at a temperature of approximately 271°C -
293°C. Also, through use of the heating rods 46, the cavity 86
is heated to a temperature of approximately 127°C - 136°C. Prior
to the injection of the molten plastic into the cavity 86 from
the vessel 36, the outer blocks 41 and 42 are held secured
10 against one another at the mating surface 89 with a force in the
order of magnitude of one hundred tons.

When the plastic is injected into the cavity 86 via
passageways 38 and 39, the force of the molten plastic against
15 the die 59 causes the die to rise, thereby increasing the volume
of cavity 86 and its thickness. During this period of time,
little, or no, force is exerted on die 59 through the piston 49.
Since the cavity increases in volume, and particularly since the
center of the cavity has a greater thickness because of the
20 movement of die 59, the knit line described in conjunction with
FIG. 3 is not formed. In the presently preferred embodiment the
injection of the molten plastic into the cavity 86 takes
approximately ten seconds.

25 Following the injection of the molten plastic into the
cavity 86, hydraulic fluid is applied to the cylinder 48, through
line 50, causing the upper die 59 to compress the molten plastic
within cavity 86. By way of example, such pressure is exerted
for a period of approximately thirty seconds with a total force
30 of approximately twenty tons. During this period of time, molten
plastic is forced from the cavity 86 back through the inlet
passageway 39 where the flow is restricted by the shut-off piston
100 which isolates the cavity from the runner system. This
"backing out" action further enhances the elimination of knit
35 line by forcing a mixing of the plastic from the two flow paths.

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1 Once the upper die 59 begins to compress the molten
plastic within cavity 86, the overflow piston 110, which had been
in a locked position, is released, and after a small portion of
the excess plastic to be forced out of cavity exits from the
5 cavity, the inlet passageway 39 becomes filled with plastic. As
more plastic is pushed out of the cavity, the plastic already in
the inlet passageway 39 exerts a force on the piston 110 forcing
it to depress as the plastic fills the cylinder 112. A notch 118
10 along the top surface of the overflow piston 110 allows the
plastic flowing into the cylinder 112 to exert an axial force
against the piston 110 such that the piston 110 is forced
downward against the force of the spring 114. The pressure on
the die 59 causes the volume and thickness of cavity 86 to
15 decrease, and particularly decreases the center thickness of the
cavity. In this way, a lens of a desired thickness may be
fabricated, including bifocal lenses.

 In the presently preferred embodiment, the travel of
die 59 is controlled by the length of time elapsing after molten
20 plastic enters cavity 86 and pressure is applied to the die 59
through piston 49. Also the final volume of cavity 86 is
controlled by the length of time that pressure is applied to the
die 59 by piston 49. Thus, if a thinner lens is desired, a
shorter period of time is allowed to lapse between the injection
25 and application of pressure, and the pressure is maintained for a
longer period of time. If a thicker lens is desired, a longer
period of time is allowed to run before pressure is applied and
the pressure is maintained for a shorter period of time.

30 Following the period of time during which the overflow
or transfer occurs, the pressure is relieved from the cylinder 48
allowing a release of the pressure applied to the plastic within
cavity 86. Typically, the pressure is released for two to three
seconds. During this period of time the overflow back through
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1 the inlet passageway 39 ceases, since the molten plastic begins
to cure. For some applications this release of pressure may not
be necessary before curing begins.

5 . Following this two or three second period of time,
force (of approximately twenty tons) is again applied to the die
59. This force continues for a period of approximately two
minutes, during which time the plastic within the cavity is
cured. The pressure applied to the die during this period of
10 time assures that the surface of the blank remains smooth and
optically correct, since as the plastic cures it tends to shrink
and pull away from the die surfaces. However, since the die is
being urged against the blank, a smooth surface matching the
compensated optical inserts is maintained during this curing
15 period. The resultant blank is distortion free.

While in the disclosed embodiment the upper die 59
moves relative to the fixed lower die 60, it will be appreciated
that the lower die may be moved towards a fixed upper die, or
20 that both dies may move. Moreover, while in the disclosed
embodiment, electric heating rods 46 are shown, other heating
means, such as fluid heating means may be utilized to heat the
apparatus. Also a vacuum exhaust may be applied to the cavity 86
prior to the time that flow begins into nozzle 35. Conventional
25 vacuum exhaust may be used for this purpose. Cooling fluids may
also be used to cool the cavity 86 during curings.

It will be appreciated that the times, temperature and
forces set forth in the above example may be varied.

30 Also, in the presently preferred embodiment, the
pressure exerted against the upper die 59 by the injected molten
plastic is used to raise this die, thus increasing the volume of
cavity 86. However, the die may be raised mechanically prior to
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1 the time that plastic is injected into the cavity with the same
result.

5 When the finished blank is removed from the cavity 86
its appearance is that of the finished blank 10 illustrated in
FIGS. 1 and 2. This blank may then be coated with a scratch
resistant coating, in a manner known in the prior art. Other
known operations such as cutting, coloring, cleaning, etc. may be
performed on the finished blank.

10 A problem similar to the knit line problem discussed in
conjunction with FIGS. 1a-1d also occurs for lenses which are
thinner at their outer edges than at their centers, such as large
plus lenses with approximately one millimeter edge thickness.
15 The disclosed method and apparatus may be used to solve this
problem.

Thus, an apparatus and method for injection molding a
lens has been disclosed. The lens is fabricated in a single
20 injection molding operation, and unlike prior art methods, a
pre-formed blank is not required. In addition, the fabricated
lens requires few finishing operations to be performed on it
since transfer pockets do not have to be removed from finished
lens. With the disclosed apparatus many high quality ophthalmic
25 and instrument lenses may be produced from a single injection
molding apparatus, at substantially lower costs than is possible
with prior art techniques and apparatuses.

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35

1 Claims:

1. An apparatus for injection molding a lens
comprising:

5 a housing (41, 42)
 a pair of dies (59, 60) disposed within said
housing (41, 42), said dies (59, 60) defining a cavity
(86) for receiving molten plastic therebetween;
 means (54, 55) within said housing (41, 42) for
10 permitting the relative movement of said dies (59, 60)
such that the volume of said cavity (86) may be varied;
 injection molding means (35) communicating (39,23)
with said cavity (86) for injecting plastic into said
cavity (86), said injection molding means (35) communi-
15 cating with said cavity through an inlet port;
 compression means (48, 49) coupled to at least
one of said dies (59, 60) for sequentially reducing the
volume of said cavity (86) and for applying pressure to
said plastic in said cavity (86) after said plastic is
20 injected through said inlet port (12) into said cavity
(86), causing a portion of said plastic to be trans-
ferred from said cavity back through said inlet port;
 whereby molten plastic may be injected into said
cavity (86), and then the volume of said cavity (86) may
25 be decreased forcing molten plastic from said cavity
back through said inlet port.

2. The injection molding apparatus of claim 1
further comprising means (100) for cutting off the flow
30 of molten plastic into said cavity (86).

3. The apparatus of claim 2 wherein said means
for cutting off the flow of molten plastic comprises a
piston (100) , said piston isolating the cavity (86)
35 from said injection molding means (35) while in a first

1 position, and allowing passage of molten plastic from
said injection molding means (35) to said cavity (86)
while in a second position.

5 4. The injection molding apparatus of one of the
preceding claims, further comprising means (110, 112) to
accomodate said molten plastic transported from said
cavity (86) back through said inlet port.

10 5. The injection molding apparatus of claim 4
wherein said means to accomodate said molten plastic
comprises

a spring loaded piston (110) housed within
15 an elongated reservoir (112);
a stop means for locking said dies (59, 60) in
a first position, whereby when said piston
(100) is locked in said first position and
pressure is applied to said piston (110), excess molten
20 plastic is prevented from entering said reservoir (112)
and when said piston (110) is released, the pressure of
the excess molten plastic will depress said piston (110)
thereby filling said reservoir (112) with molten plastic.

25 6. The injection molding apparatus of one of the
preceding claims wherein one (60) of said pair of dies
(59, 60) is fixed and the other (59) die moves relative
to said fixed die (60).

30 7. The injection molding apparatus of one of the
preceding claims including heating means (46) for heating
said cavity.

8. The injection molding apparatus of claim 8
or 9 wherein said other die (59) is mounted such that
35 when plastic is injected into said cavity (86), the vo-

1 lume of said cavity (86) is increased by the pressure
of such in-flowing molten plastic.

5 9. A method for forming a thermoplastic optical
lens blank in an injection molding apparatus, especially
according to one of the preceding claims where said appa-
ratus includes an optical cavity for defining said op-
tical lens blank comprising the steps of:

10 injecting molten plastic into said cavity
through an aperture along the edge of said cavity when
said cavity has a volume greater than said optical lens,
said greater volume to assure better flow into the
thinner section of said cavity; and

15 compressing said cavity such that the thick-
ness of said cavity is decreased so as to define said
optical lens blank, thereby causing a flow of molten
plastic from said optical cavity back through said aper-
ture;

20 whereby an optical lens free of knit lines is
formed.

25 10. The method defined by claim 9 including the
step of curing said lens blank in said cavity after said
flow of molten plastic from said cavity has ceased.

30 11. The method defined by claim 10 wherein pressure
is applied to said blank during said curing so as to pre-
vent shrinkage-caused distortions during curing.

35 12. The method defined by one of the claims 9 to
11 wherein said molten plastic comprises polycarbonate.

 13. The method defined by one of the claims 9 to
12 wherein said cavity is heated prior to said injecting
of molten polycarbonate into said cavity.

1 14. A method for forming a thermoplastic optical
lens free of knit lines in an optical lens defining cavity
comprising the steps of:

5 injecting molten plastic into said cavity
through an aperture along the edge of said cavity, ex-
panding said cavity to a volume greater than said optical
lens by the force of said injected molten plastic acting
upon the services defining said cavity during said in-
10 jection of said molten plastic;

applying a first pressure to said services
defining said cavity so as to urge molten plastic to
flow from said cavity back through said aperture along
said edge of said cavity;

15 applying a second pressure to said services
and said molten plastic as said molten plastic cures.

15. The method of claim 14 wherein said first
pressure decreases the thickness of said cavity thereby
urging said molten plastic from said cavity back through
20 said aperture, said first pressure being applied until
said cavity substantially defines said optical lens.

25 16. The method defined by claim 14 or 15 wherein
said molten plastic comprises a molten polycarbonate.

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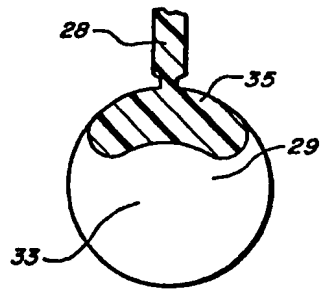


FIG. 1A

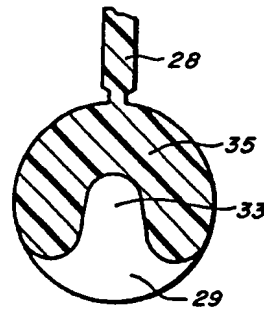


FIG. 1B

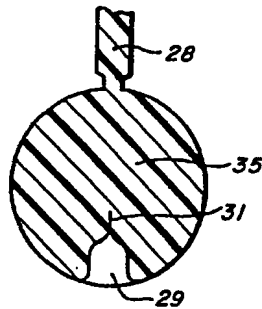


FIG. 1C

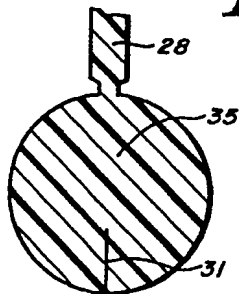


FIG. 1D

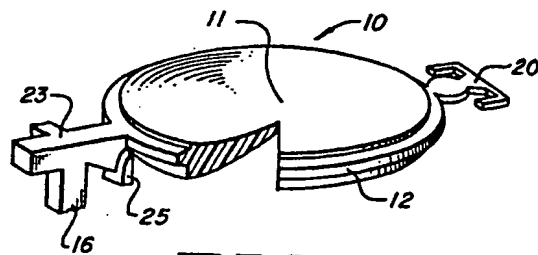


FIG. 2

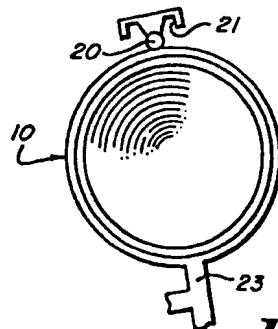


FIG. 3

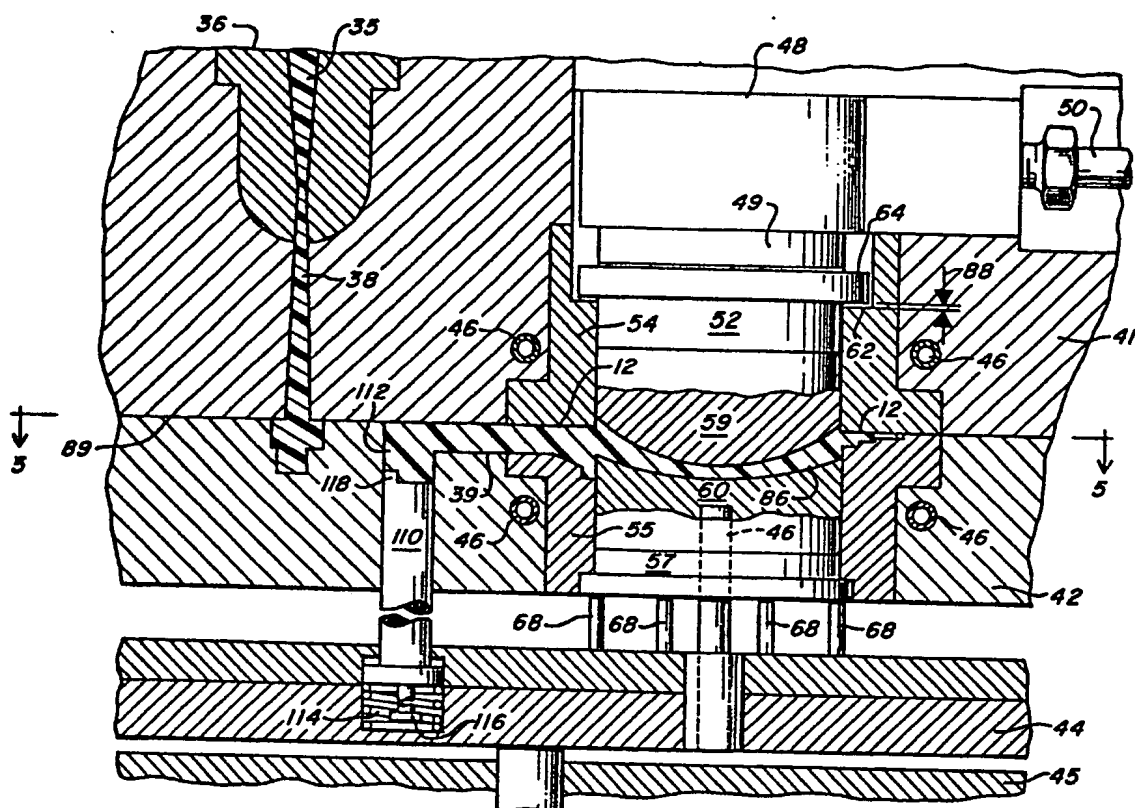


FIG. 4

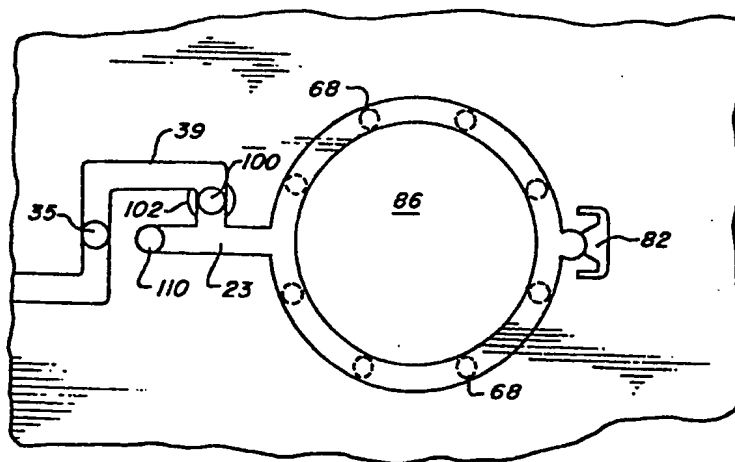


FIG. 5



European Patent
Office

EUROPEAN SEARCH REPORT

0144622

Application number

DOCUMENTS CONSIDERED TO BE RELEVANT			EP 84112163.5
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X,D	<u>US - A - 4 091 057</u> (WEBER)	1,4-16	B 29 D 11/00
Y	* Totality *	2,3	
	--		
Y	<u>AT - B - 349 205</u> (SOCIÉTÉ GIR. PI.)	2,3	
	* Totality *		
	--		
X,D	<u>US - A - 4 008 031</u> (WEBER)	1,4-16	B 29 C B 29 D
Y	* Totality *	2,3	
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Y	<u>DE - B - 1 919 435</u> (ROBERT FINKE)	2,3	
	* Totality *		
	--		
X	<u>US - A - 4 364 878</u> (LALIBERTE)	1,6-8	B 29 C B 29 D
A	* Totality *	9,12,13,15,16	
	--		
X	<u>GB - A - 2 050 928</u> (OMNITECH)	1,6,8	
A	* Totality *	9,12-16	
	--		
A	<u>GB - A - 581 197</u> (JOHN JOHNSON)		
	* Totality *		

The present search report has been drawn up for all claims			
Place of search VIENNA		Date of completion of the search 21-02-1985	Examiner REININGER
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			